DRAFT BTeV RISK MANAGEMENT PLAN

This document describes the Risk Management Plan (RMP) for the BTeV project. This RMP provides a structured and integrated process for identifying, evaluating, tracking, abating, and managing project risks in terms of three risk categories: cost, schedule, and technical performance. The management and mitigation of Environment, Safety, and Health (ESH) risks are very important. These risks have been identified in the BTeV Preliminary Hazards Analysis Report, and they are managed through Integrated Safety Management. Therefore this RMP does not focus on assurance of safety and environmental protection.

Any project faces both threats and opportunities and must strive to exploit the opportunities while ensuring that the threats do not derail the project. Numerous informal and formal approaches are used for identifying threats and opportunities, assessing their likelihood, prioritizing them for possible mitigation or exploitation, and devising strategies to do so. The key to successful risk management is alertness to potential risks and a deliberate approach to accepting, preventing, mitigating, or avoiding them. The BTeV project becomes aware of potential risks in many ways, notably during work planning, meetings, reviews, and via lessons learned from others. Routine meetings, such as weekly Technical Board meetings, routine WBS Level 2 system meetings, and monthly progress meetings, provide important forums for identifying, discussing, and resolving key risk areas and developing and adopting mitigation plans. Risk has been managed during the planning and design phase by implementing appropriate actions, such as ensuring adequate contingency and schedule float, pursuing multiple parallel approaches, and/or developing backup options. Detector construction projects are well within the experience and expertise of the BTeV collaboration. Every effort has been made to specify these projects in a manner that reduces the risk to an acceptably low level.

The technical risks facing the BTeV Project are no greater than those facing other HEP projects, and as in them, risks that are identified will be managed as early as possible to assure that they do not derail the timely completion of the project or stress its budget in unexpected ways. The initial risk assessment indicates the project will have low cost, schedule, and technical risk exposure, with the exception of the Pixel Detector and EMCAL, which were assessed to have a moderate risk level. Another source of moderate risk affects schedule, and it is due to potential delays in the appropriation and release of project funding.

Because contingency is one of the major resources available to deal with problems arising during project execution, the management of cost, schedule and technical risks

and the management of contingency are closely linked. Proactive risk identification and mitigation can therefore reduce pressure on contingency, by reducing the probability of unpleasant surprises that could require contingency to resolve.

1.1 RESPONSIBILITIES

The BTeV Project Director has delegated the responsibility for overall project risk management to the BTeV Project Manager. The BTeV Project Director and BTeV Project Manager share the responsibility for managing contingency, consistent with the change control process and thresholds described in the PEP. The objectives are to maintain contingency conservatively commensurate with project risks through project completion, to ensure that the full project scope is achieved on schedule.

The BTeV Project Director is responsible for:

- Approving the BTeV risk management approach
- Providing oversight for the BTeV risk identification and mitigation process

The BTeV Project Manager is responsible for:

- Developing the BTeV Risk Management approach
- Scheduling periodic reviews of project risks
- Assuring that risk analyses results are appropriately documented, tracked, and closed
- Participating in the project's risk management process, including risk determinations and mitigations
- Approving, modifying, or assisting in BTeV risk abatement strategies
- Chairing the BTeV Risk Management Board

The BTeV WBS managers are responsible for:

- Performing risk analysis including identification of potential risks to the technical, cost, and schedule success of their WBS system, determining their likelihood of occurring, and estimating their potential impact on the project.
- Developing and executing risk mitigation strategies for their Level 2 system
- Informing the BTeV Project Manager about the significant risks and the status of risk mitigation strategies in their WBS system
- Serving as a member of the BTeV Risk Management Board

The BTeV Quality Assurance Program Coordinator is responsible for:

- Assisting the WBS managers in identifying and evaluating risks
- Assisting the BTeV Project Manager in tracking and reporting risk
- Reviewing and updating the BTeV RMP as necessary
- Serving as secretary of the BTeV Risk Management Board
- Maintaining Documentation of BTeV Risk Management activities

(This role, carried out by the BTeV QAP Coordinator, is that of the BTeV Risk Management Coordinator.)

The BTeV ESH Coordinator is responsible for:

- Serving as a resource to BTeV WBS managers for identifying and mitigating environment, safety, and health risks and potential regulatory issues
- Assisting the BTeV Project Manager in ensuring that risk-management approaches do not have unintended adverse environment, safety, or health consequences
- Serving as a member of the BTeV Risk Management Board

The BTeV Risk Management Board (RMB) (Consisting of the BTeV Project Manager, BTeV Project Director, BTeV Technical managers, and ESH and QAP Coordinators) is responsible for:

- Reviewing and recommending approval or modification of risk analyses and risk mitigation strategies, as requested by the BTeV Project Manager
- Strategizing and assisting in the development of risk abatement strategies as needed

The RMB will meet at least quarterly but may meet more frequently as needed.

1.2 THE BTEV RISK MANAGEMENT PROCESS

The BTeV Risk Management approach consists of a five step process: (1) identifying potential project risk, (2) analyzing project risk (3) planning risk abatement strategies (4) executing risk abatement strategies and (5) monitoring the results of and revising risk abatement strategies.

1.2.1 Step 1: Identifying Project Risk. The BTeV Risk Management process begins with the WBS managers evaluating potential project risk for each technical equipment item and subsystem that exceeds $250K in value or is on the BTeV critical path. A table of common risk areas has been included in Appendix A as a tool to assist BTeV WBS managers in identifying areas of project risk.

1.2.2 Step 2: Analyzing Project Risk. BTeV project risks are analyzed by considering their likelihood or probability of occurring together with the consequence to the project's technical performance, cost, and/or schedule baselines. Probability is assessed qualitatively as **unlikely**, **likely**, and **very likely**.

Consequence relates to the potential impact of the threat on cost, schedule, and/or the technical baselines. Each threat will be evaluated on these three aspects using the criteria and thresholds in Table 1. The highest (worst) consequence determines the overall consequence rating for the threat.

Table 1: Consequence Assessment Matrix

Consequence / Risk Area	Low	Moderate	Critical
Cost: Worst likely impact:	≤ $25K	≤$200K	>$200K
Schedule: Worst likely impact:	< 1 week delay of critical path or major milestone	Delays major milestone or critical path by <1 month	Delays major milestone or critical path by >1 month
Technical: Worst likely impact on scope or performance:	Negligible, if any, degradation	Significant technical/scope degradation	Baseline scope will not be achieved.

Based on the combination of probability and consequence, risks are classified as high, moderate or low in accordance with the categorization provided in Table 2. Probability percentages in Table 2 are meant as qualitative guides, not as absolute thresholds.

Table 2: Risk Classification Matrix

	Consequence		
Probability	**Low**	**Moderate**	**Critical**
Very Likely (p > 80%)	Moderate	Moderate	High
Likely (20% < p < 80%)	Low	Moderate	High
Unlikely (p < 20%)	Low	Low	Moderate

1.2.3 Step 3: Planning Risk Abatement Strategies. BTeV WBS managers are responsible for developing appropriate risk abatement strategies to accept or mitigate project risk. Note that some risks might be recognized too late for mitigation, and that time may run out for risk mitigation. Tables of common risk area and abatement strategies has been included in Appendix A as a tool to assist WBS managers in addressing project risk. The BTeV Risk Management Coordinator and Project Manager are also available to assist BTeV WBS managers in risk abatement planning.

If a WBS manager identifies any risk item that is classified as moderate or high risk, then the risk analysis must be reported to the BTeV Project Manager in documented form. Low-risk items may be documented at the discretion of the WBS manager. The risk report should describe how the risk was classified, and include the analysis of risk level

described in section 1.2.2 along with the risk abatement strategy preferred by the WBS manager. The strategy could propose simply to accept the risk and deal with it, if it materializes. Appendix B summarizes the risk-based contingency analysis employed prior to CD-1.

Upon receiving the documented risk notice, the BTeV Project Manager will be responsible for accepting or rejecting the risk level and mitigation strategy being reported by the WBS manager and for deciding if the risk would benefit from additional review by the BTeV Risk Management Board. The charter of the Board is to provide an objective and independent review of risk analyses and risk abatement strategies reported by BTeV WBS manager, and to recommend approval or modification of risk analyses and/or abatement strategies. The BTeV Project Manager serves as the chairman of the Risk Management Board and is responsible for scheduling the review. The BTeV QAP Coordinator serves as the secretary, and is responsible for documenting the meeting results. The BTeV Project Manager and QAP Coordinator are also responsible for assisting the WBS manager in developing an alternative risk mitigating strategy if the WBS manager's risk abatement strategy is rejected.

The BTeV Project Manager will have identified risk items entered into the Risk Management Database, discussed in section 1.6.1, for tracking purposes. Examples of entry forms and reports for the database are included in Appendix C. This database will assign a tracking number and ownership, identify a risk-retirement date (if appropriate), and generate status reports to be discussed in a graded manner at the BTeV Project Management Meeting. Graded means that tracking risk management issues will not be a topic at each meeting, and that when risk management is a topic, the discussion will focus only on the most important or timely risk items.

1.2.4 Step 4: Executing Risk Abatement Strategies. The BTeV WBS manager is responsible for performing the work consistent with the plan for mitigating risk, and for keeping the BTeV Project Manager informed of the status of the work, including its risk status.

1.2.5 Step 5: Monitoring and Revising Risk Abatement Strategies. WBS managers and BTeV project management will monitor the performance of work vis-à-vis risk, evaluate the success of risk mitigation strategies, and address project risk issues on a continuing basis. Work plans and mitigation strategies will be adjusted continuously to take advantage of lessons learned and maximize the probability for successful project completion.

1.3 TECHNICAL RISK

Preparation of clear and concise specifications, judicious determination of subcontractor responsibility and approval of proposed lower tier sub-subcontractors, and implementation of QA provisions will minimize technical risk. Projects have been

designed to further minimize technical risk by exploiting previous experience to the greatest extent possible, and minimizing exposure to single vendor failures.

Making deliberately conservative design choices, where possible, and carrying out extensive detector R&D where new technologies are involved has minimized technical risk throughout the BTeV Project. Use of single sided sensors for the forward microstrip tracker, extensive R&D on the silicon pixel detector and the RICH readout, use of a switch based on commercial off-the-shelf components in the data acquisition system, reduction in component variety, and common integrated circuit technologies wherever possible will reduce risk. Use of the LHC magnet design, which was developed at Fermilab, is another example. In all cases, the expertise of personnel involved in the design and implementation of previous versions of BTeV systems have been exploited to the fullest possible extent. Moreover, institutional commitments have been carefully crafted within the subprojects in order to help ensure timely and successful completion of the Project.

1.4 COST RISK

Use of fixed-price subcontracts and competition will be maximized to reduce cost risk.

1.5 SCHEDULE RISK

As outlined in Section 7.3 of the ASP, schedule risk will be minimized via:

- Aggressive R&D, including bench testing and beam testing
- Realistic planning,
- Verification of subcontractor's credit and capacity during evaluation,
- Close surveillance of subcontractor performance,
- Advance expediting, and
- Incremental awards to multiple subcontractors when necessary to assure total quantity or required delivery.

Incentive subcontracts, such as fixed-price with incentive, will be considered when a reasonably firm basis for pricing does not exist or the nature of the requirement is such that the subcontractor's assumption of a degree of cost risk will provide a positive profit incentive for effective cost and/or schedule control and performance.

In addition, the Project will be tracked monthly, with schedule changes carefully monitored and approved through a change control process overseen by a combination of the Project Manager, the Laboratory Directorate, and DOE .

1.6 RISK MANAGEMENT TOOLS AND PRACTICES

1.6.1 Risk Management Database:

Risk assignments are associated to specific WBS entries. The WBS number will also serve as the Risk Index. Risk information, including the probability and consequence assessments and brief summaries of mitigation strategies, are stored with the WBS elements in the OpenPlan Database. This serves to emphasize the role of the Level 2 WBS manager in risk management.

1.6.2 Risk "watchlist":

The Project Management will maintain a list of all activities assigned a severity of risk of high or moderate. The list will include the status of the WBS activity, key risk-related dates, and the status of the various risk mitigation strategies. It will be used to identify the most imprtant and/or timely risk items.

1.6.3 Integration of Risk Management with other BTeV Activities:

Risk management is a line activity in BTeV and, as such, will be a normal part of many activities and meetings. The BTeV Project Management meetings will take up risk issues from time to time. The BTeV Technical Board, which meets weekly, will also regularly include reports from Level 2 managers that will address risk-related issues.

APPENDIX A: RISK MANAGEMENT TOOLS

Table A-1: Common Risk Areas

Project Risk Areas	Significant risks
Facilities and Equipment	Major equipment development Inadequate planning for long lead items and vendor support.
Design	Design relies on immature technologies or "exotic" materials to achieve performance objectives. Design not cost effective. Software design, coding, and testing.
Requirements	Operational requirements not properly established or vaguely stated. Software requirements not properly established or vaguely stated. Requirements are not stable. Requirements are too restrictive— cost risk.
Testing/Evaluation/ Simulation	Test planning not initiated early in program (Initiation Phase). Testing does not address the ultimate operating environment. Test procedures don't address all major performance and suitability specifications Facilities not available to accomplish specific tests, especially system-level tests. Insufficient time to test thoroughly. Project lacks proper tools and modeling and simulation capability to assess alternatives.
Schedule	Funding profile not stable from budget cycle to budget cycle. Schedule does not reflect realistic acquisition planning. Schedule objectives not realistic and attainable. Resources not available to meet schedule.
Supplier Capabilities	Inadequate supportability late in development or after fielding, resulting in need for engineering changes, increased costs, and/or schedule delays. Restricted number of available vendors Restricted production capacity
Cost	Realistic cost objectives not established early. Funding profile does not match acquisition strategy.
Technology	Project depends on unproven technology for success with no alternatives. Project success depends on achieving advances in state-of-the-art technology. Potential advances in technology will result in less than optimal cost-effective system or make system components obsolete. Technology has not been demonstrated in required operating environment. Technology relies on complex hardware, software, or integration design.
Management	Acquisition strategy does not give adequate consideration to various essential elements, e.g., mission need, test and evaluation, technology, etc. Subordinate strategies and plans are not developed in a timely manner or based on the acquisition strategy. Proper mix (experience, skills, stability) of people not assigned to the project. Effective risk assessments not performed or results not understood and acted upon.

Table A-2: Common Risk Abatement Strategies

BTeV Project Risk Category			
Project Impact	High/Very High	Moderate	Low/Very Low
Cost	Closely monitor cost and spending Consider implementing phased procurements Obtain Multiple bottoms-up independent cost estimates Perform Value Engineering Visit Vendor Apply aggressive cost control	Closely monitor cost and spending Obtain at least two bottoms-up independent cost estimates Apply cost control	Quality controls applied as defined in BTeV QA program
Schedule	Increase lead time substantially by initiating procurements 6-8 weeks early Visit Vendor Evaluate in-house procurement Contract incentives/penalties Maintain vendor oversight	Increase lead time by initiating procurements 2-4 weeks early Visit Vendor Evaluate in-house procurement Contract incentives/penalties Maintain vendor oversight Add additional vendors	Quality controls applied as defined in BTeV QA program
Performance	Perform major redesign Increase prototype cycles Evaluate alternate technology Request additional process control steps during fabrication Define extensive QA/acceptance testing Increase lead time/increase testing cycles	Moderate redesign as required Define QA/acceptance testing Increase prototype acceptance tests	Quality controls applied as defined in BTeV QA program

APPENDIX B: RISK BASED CONTINGENCY MANAGEMENT

Table B-1: Probability of occurrence of risk event used before CD-1

Risk Rating	Probability of Failure	Interpretation
Extremely High	0.99-0.81	Beyond state of the art technical problems assured
Very High	0.80-0.61	Beyond state of the art technical problems likely
High	0.60-0.50	Latest technology, not fully developed – technical problems likely
Moderate	0.49-0.25	Best technology – minimal technical problems expected
Low	0.24-0.10	Practical technology – no technical problems expected
Very Low	0.09-0.01	Product in use

Table B-2: Consequence/Impact factors used before CD-1

	Very Low Risk 0.05	**Low Risk 0.1**	**Moderate Risk 0.2**	**High Risk 0.4**	**Very High Risk 0.8**
Cost Objective	Insignificant cost increase	<5% cost increase	5-10% cost increase	10-20% cost increase	>20% cost increase
Schedule Objective	Insignificant schedule slippage	Schedule slippage <5%	Overall project slippage 5-10%	Overall project slippage of 10-20%	Overall project slippage >20%
Scope Objective	Scope decrease barely noticeable	Minor areas of scope affected	Major areas of scope affected	Project scope reduction unacceptable for physics objectives	Scope of project effectively useless for mission
Technical Objective	Technical degradation of project barely noticeable	Technical performance of final product minimally affected	Technical performance of final product moderately affected	Degradation of technical performance unacceptable for physics objectives	Technical performance of end item effectively useless for mission

APPENDIX C: RISK MANAGEMENT FORMS

Table C-1: Risk Event Identification and Assessment Form

WBS Number	Risk Event	Probability	Impact	Severity

Table C-2: Risk response/mitigation strategy form

WBS Number	Risk Event	Response/Mitigation Strategy

Project name: **Preparer's name:** **Date:**